Coastal and Continental Shelf Processes in Ghana

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LONG-TERM GOALS

The on-going research has laid the necessary foundation for the University of Ghana to achieve the long-term objective of becoming a Centre of Excellence in coastal processes research and training. The research findings would provide sound basis for the formulation of science-based policies for effective coastal area management. Another long term goal is to provide leadership which would ensure that similar capacity for research in coastal processes is developed in other countries in the region.

OBJECTIVES

The focus of the research is to employ satellite remote sensing coupled with field surveys to address maritime concerns specifically in Ghana and by extension the Guinea Current Large Marine Ecosystem region. The specific objectives include:

1. investigation of processes governing shoreline change in Ghana
2. development of algorithms for detection and monitoring of vessel traffic and oil slicks
3. investigation of meso-scale oceanographic phenomena (e.g. coastal upwelling, fronts, eddies) in the Gulf of Guinea

APPROACH

The entire 550 km of Ghana's shoreline is generally vulnerable to erosion. As part of the implementation strategy, thirty-three (33) ground control points (GCP) have been established along the entire coastline, and coordinated to the Ghana metre grid. The GCPs serve as reference points for regular Real-Time Kinematic (RTK) survey of the coast. The framework for the monitoring program was established through collaboration with scientists from the United States and Europe (i.e. University of New Hampshire, United States Geological Survey, Woods Hole Oceanographic Institution, and UNESCO-IHE of Netherlands). The coastal and continental processes research is being carried out at different spatial scales – (1) large scale coastline development of order 100 - 1000 km, (2) large scale shelf processes of order 100 - 1000 km, (3) large scale nearshore processes of order 10 - 100 km, and (4) medium scale coastal inlets and adjacent beaches of order 1 - 10 km. In view of the role waves play in coastal dynamics, a directional waverider was deployed off Cape Three points at 4^0 13' 58.38'' N and 1^0 38' 54.42'' W. The data would be integrated with other measurements in modeling.

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WORK COMPLETED

The main activity during the fiscal year involved intensive RTK monitoring of selected sites along the coastline to improve on estimation of rate of shoreline change.

Previous studies on shoreline erosion led to zoning of the shoreline into western, central and eastern based on the geomorphology of the coast (e.g. Ly, 1980; Wellens-Mensah *et al*., 2002). The west coast comprises of fine sand with gentle beaches backed by coastal lagoons. The central coast represents an embayed coast of rocky headlands and littoral sand barriers enclosing coastal lagoons. The eastern coast is completely sandy and characterized by the deltaic features of the Volta River. Although using the geomorphology as a basis for zoning the coast has enabled a comprehensive description of the coastal zone, the similarities of features in all the three regions make such reference inappropriate. Hence, a different system of zoning the shoreline was adopted based on the orientation of the shoreline. This gave rise to four sections namely western corner section (WCS), mid section (MS), eastern section (ES) and eastern corner section (ECS) (Figure 1).

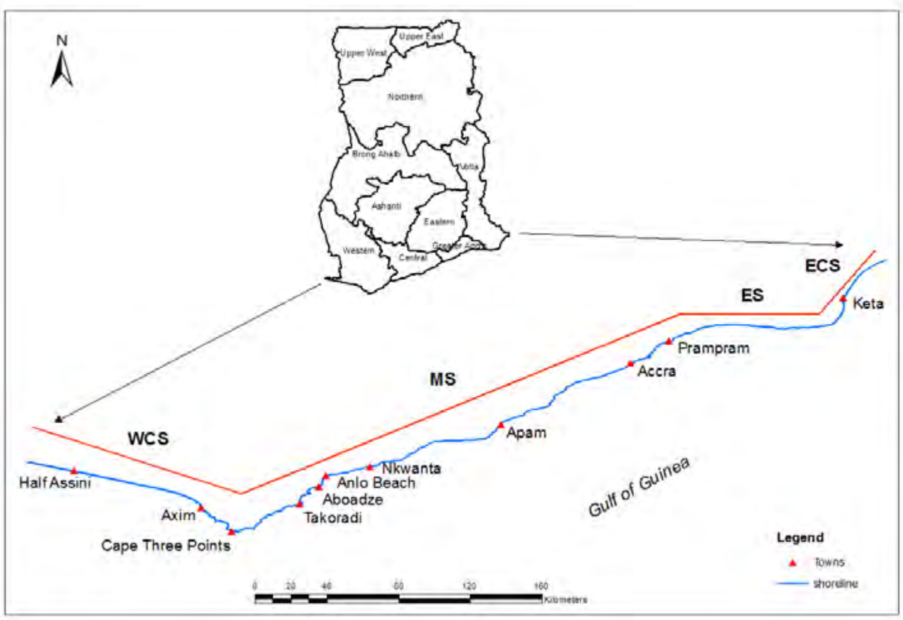


Figure 1. Classification of the coastline of Ghana based on orientation (WCS – western corner section; MS – mid section); ES – eastern section; and ECS – eastern corner section).

The shoreline orientation influences how breaking swell waves and seas interact at the various sections of the coast to drive shoreline change. The orientation also regulates alongshore sediment transport, which is reported to move from west to east (Wellens-Mensah *et al*., 2002).

In previous estimation of historic rate of shoreline change (i.e. FY10 report), the End Point Rate (EPR) method was adopted. This was because it requires only two shoreline positions to obtain a rate of change. Albeit, there was only 1974 and 2005 digitized data of high resolution available for Ghana. The EPR approach has inherent sources of uncertainty which might affect the reliability of computed rate of change (Genz *et al*., 2007). Hence, the rate determination was improved upon by using the

linear regression method after obtaining a third baseline from RTK surveys of selected sites during the year. For the data analysis, transects were cast along the entire coast at 50m spacing using a smoothing distance of 200m to orient transects around curved sections of the baseline. The computation was carried out using Digital Shoreline Analysis System in ArcGIS (Himmelstoss, 2009).

RESULTS

The results showed that the entire coast of Ghana is dominated by erosion with an average rate of 1.58 m/year over a period from 1974 to 2005. In total, 8% of the shoreline experienced accretion at an average rate of 1.67m/year (Figure 2).

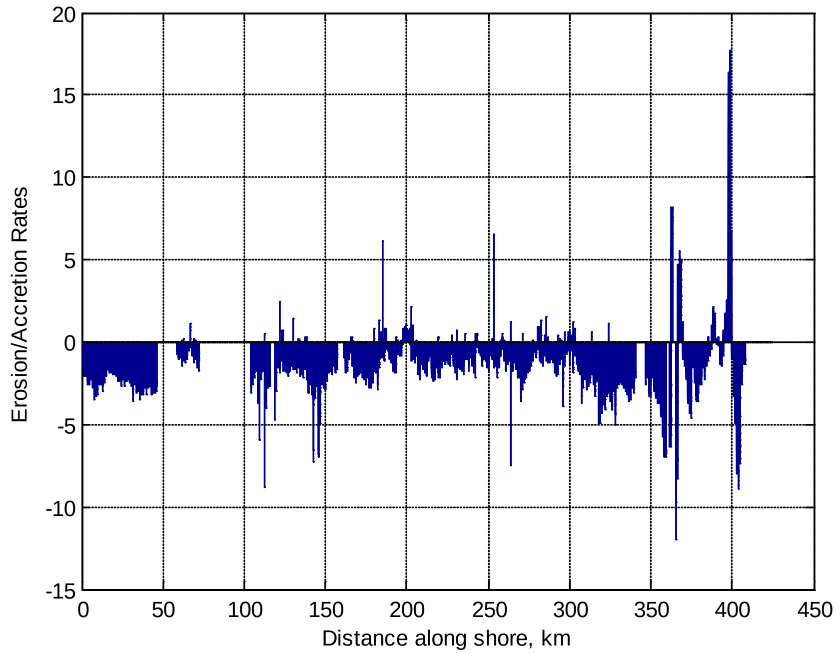
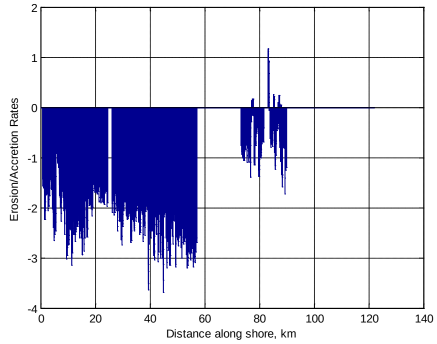
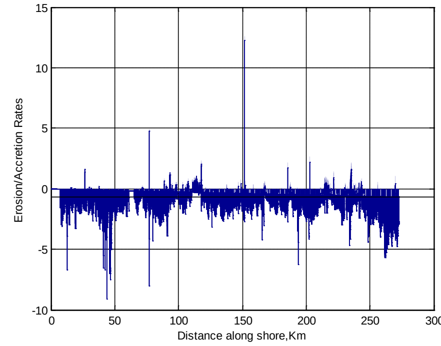


Figure 2. Overall erosion and accretion rates for Ghana

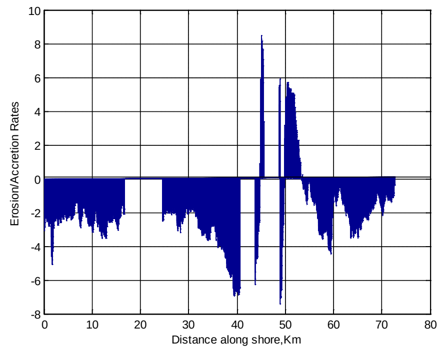
It was observed that the various zones along the coast exhibited different rates of shoreline: ECS (1.79 m/year), MS (1.11 m/year), ES (2.50 m/year), and ECS (2.31 m/year) (Figure 3). The maximum annualised uncertainty was estimated to be 0.29m/year.



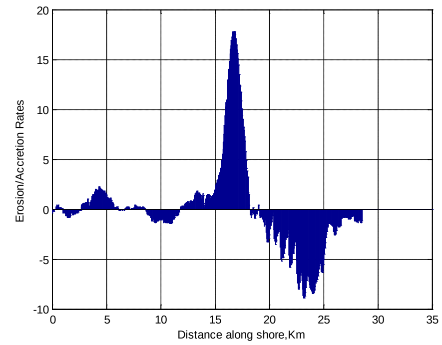
(a) Western corner section



(b) Middle section



(c) Eastern section



(d) Eastern Corner Section

Figure 3: Shoreline rates of change at respective zones along the coast of Ghana

The results obtained for the specific sites where RTK was carried indicated clearly that some areas were eroding faster than the average rate for the particular zone (Table 1). It was interesting to note that at a location close to the Keta Sea Defence (i.e. ES section), accretion was as high as 17.74m/year, indicating the effectiveness of the defence intervention.

Table 1: Change Rate Statistics for Selected Areas (show positions on map)

Area	Erosion (m/year)	Accretion (m/year)	Coastal Section
Half Assini	2.42	-	WCS
Takoradi	1.23	-	MS
Aboadze	2.33	-	MS
Anlo Beach	2.20	-	MS
Nkwanta - Bantoma	1.60	-	MS
Accra (Art Centre)	0.53	-	MS
Nungua	0.89	0.46	MS
Prampram	1.97	-	ES
Ada	4.40	-	ES

Information on shoreline change on short term scales is very important in coastal management. Over such short term scales, there could be alternate seasonal accretion and erosion taking place. As part of the project, weekly surveys were carried out at Prampram beach over a six month period. A novel approach (i.e. Average of Relative Rates, ARR) for estimating shoreline change, was adopted. This method appeared to be a reliable estimate compared to the Average Of Rate (AOR), and the End Point Rate (EPR) methods. The estimated rate of shoreline change was 0.5 ± 0.4 meters/week (Sowah et al., 2011). This indicated a high variability accounted for by alternating erosion and accretion, an indication of seasonal influence of the oceanographic regime on the coast.

IMPACT/APPLICATIONS

The research is having significant impact on academic related programs at the University of Ghana. Through a collaborative effort with our external partners, novel investigative approaches in coastal processes research are being developed. Government Ministries, Departments and Agencies are benefitting from the outcome of the research. This would be translated into development of pragmatic policies for sustainably management of the coastal area.

RELATED PROJECTS

Oil slick detection

Increasing vessel traffic and tanker operations after the discovery of oil in commercial quantities in deep waters off western Ghana has made it imperative for development of algorithms to aid in routine oil slick detection. Using C-band synthetic aperture radar (SAR) imageries we are developing an adaptive thresholding technique to discriminate between clear ocean pixels and those contaminated by oil. The results would be made available for under the OSSIM open source platform.

Vessel traffic monitoring

The Gulf of Guinea continuous to experience illegal, unregulated and unreported (IUU) fishing activities, illegal oil bunkering, piracy, trafficking of human and narcotic drugs among others. Limited capacity and poor monitoring and surveillance is contributing to the increase in these illicit activities. The University of Ghana in collaboration with Ghana Navy, Ghana Fisheries, Ghana Maritime Authority and expertise support from Space and Naval Warfare (SPAWAR) of the US Navy embarked on use of synthetic aperture radar (SAR) in combination with automatic identification system (AIS) for vessel identification and detection to support maritime surveillance. The results of the research was disseminated at a stakeholder workshop held on 31 August, 2011

Ocean front detection (for fisheries management)

The Department of Oceanographic and Fisheries, through the DevCocast/EAMNet initiative is receiving partially processed ocean colour and sea surface temperature data broadcast under the GEONETCast system. Commercially important fishes are known to aggregate along fronts which exhibit high biological production. The presence of fronts are being analyzed together with tuna catch data to understand thermal variability along fronts and its impact on tuna distribution. These datasets are being processed to generate ocean frontal maps to support fisheries management.

Training of on numerical wave modeling

Dr. Kwasi Appeaning Addo and Mr. Wahab Laryea Sowah received training on morphological modeling techniques at UNESCO-IHE of The Netherlands. The training covered up to 6 months and was under the instruction of Prof Roelvink Dano.

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